Flora W. Patterson

F. W. P.

WEST VIRGINIA

AGRICULTURAL EXPERIMENT STATION.

MORGANTOWN, W. VA.

BULLETIN 66. FEBRUARY, 1900

FRUIT DISEASES AND HOW TO TREAT THEM!

By L. C. Corbett.

MYCOLOGICAL BUREAU
13 JUL 1921
OF MYCOLOGY

Downy Mildew on Fruit.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

THE REGENTS OF THE WEST VIRGINIA UNIVERSITY.

NAME OF REGENTS.	P. O. ADDRESS.
Hon. George C. Sturgiss	Morgantown
Hon. James F. Brown	Charleston
Hon. A. H. Kunst	Weston
Hon. Richard Randolph McMahon	Harper's Ferry
Hon. John J. Davis	Clarksburg
Hon. James L. Hamill	Welch
Hon. John A. Campbell	New Cumberland.
Hon. W. E. Powell	Parkersburg
Hon. P. C. Eastham	Pt. Pleasant

STATION COMMITTEE

George C. Sturgiss. - James L Hamill

James F. Brown.

President Regents	Geo. C. Sturgiss
President University	Jerome H. Raymond, A. M., Ph. D.
Treasurer	A. R. Whitehill, Ph D.
Auditor	S G Chadwick

STATION STAFF.

James H. Stewart, A. M,	Director and Agriculturist
A. D. Hopkins, Ph. D.,	Vice Director and Entomologist
Bert H. Hite, M. S.,	Chemist
L. C. Corbett, M. S.	Horticulturist
W. E. Rumsey, B. S. Agr.	Assistant Entomologist
Horace Atwood, M. S.	Assistant Agriculturist
C. D. Howard, B. S.	Assistant Chemist
E. C. Frame	Clerk and Stenographer
M. A. Stewart	Librarian

FRUIT DISEASES AND HOW TO TREAT THEM.

The progressive fruit grower of to-day knows that he can not grow high grade fruits unless he treats his plants to prevent injuries from insects and fungi.

The discussions that we read in our popular journals would lead one to suppose that all insects, as well as fungi are harmful. But all insects are not injurious, neither are all fungi destrctive or detrimental. On the contrary many of them are of the greatest assistance to the modern agriclturist. While there are a great many bad members of these societies there are also many good ones, and it is to make some of these common pests familiar to those who have to contend with them that this popular discussion of their habits, appearance and work is offered. In addition, formulae for the preparation of standard Insecticides and Fungicides are given in the accompanying Spray Calendar.

Injurious fungi are like weeds from the standpoint of the cultivator in that they are plants out of place. They are thieves, another respect in which they resemble weeds, for while weeds rob plants of the food which they should obtain from the soil parasitic fungi, i. e. fungous plants which live upon other living plants, rob them of their food after they have taken the trouble and expense of preparing it for their own use.

When viewed in this light parasitic fungi become even a more dangerous enemy than weeds. They are also to be dreaded because of their small size and the ease with which they can be overlooked until they have so far completed their work of destruction that treatment is futile.

In fact the best that we now know enables us merely to guard the plant against the attack of these diseases by employing pre-

ventive measures. Remedies are practically unknown. We can prevent and we can check the destruction being wrought by these pests but we have no remedies, i. e. we can not make good any injury already done. The plant itself must accomplish that.

Fungicides or the materials used to prevent the injury from these pests are, therefore, chiefly safe guards, yet their use has within the past few years saved millions of dollars for the fruit growers beside furnishing the consumer a higher grade commodity.

For convenience the diseases described will be discussed, regardless of their botanical relations, according to the plant which they infest.

APPLES.

Bitter Rot.

(*Gleosporium Fructigenum.*)

This rot has for many years been a common and destructive pest of the apple in the southern counties of West Virginia, particularly along the lower Ohio and Kanawha rivers.

Not until the seasons of 1899 did it appear in sufficient severity in either of the chief commercial apple regions of the State to attract attention. Its attack during the fall of 1899 so far as we are informed was confined to a single orchard and almost entirely to one sort of apples. The outbreak was first noted about August 1, when many of the partially grown fruits of the Russian Romanite or Bentley Sweet variety showed brownish spots upon the surface of the fruits, these spots enlarged rapidly at the same time assuming a more or less circular outline with the border sharply defined. In some cases two or more diseased areas joined issue and in such cases the whole fruit was soon a mass of rot.

If the decay in such fruit is chiefly confined to a single centre of infection the discolored and rotting areas are found to extend well down to the core and when the apple is cut through the discoloration will show a triangular form, with the face of the triangle measured by the discoloration on the surface and the apex

at the core of the apple as shown in Fig. 1. The affected area of the surface of the fruit appears shrunken, minute black por-

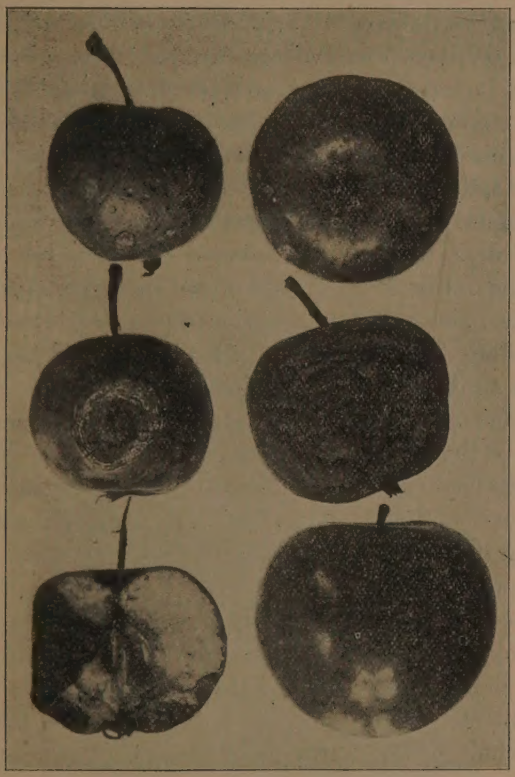

FIG. 1—Bitter Rot.

tions appear either in patches or circular areas upon the dead skin, which upon close examination are found to be reproductive bodies (spores) of fungous causing the trouble.

The fruits may, and often do, remain upon the trees long after they are entirely rotten, sometimes they dry still adhering to the tree and remain there during a great portion of the winter. The dried fruits which hang upon the tree as well as those which fall to the ground if not destroyed either by gathering

and burning or plowing under serve as a source of infection for the succeeding crop, as the spores are capable of passing the winter in the mummified fruits.

This disease produces its re-productive bodies in great abundance in a few days after the first outbreak, these bodies are capable of producing further disease spots upon sound fruits if they come in contact with them. The spread of the disease over a tree or from tree to tree is therefore, only a matter of a short time. If left without treatment the crop of fruit that promises much August 1, may by picking time be entirely ruined.

Not content with such devestation the disease is capable of continuing its work upon fruit stored in buildings not held at the low temperature of ice or mechanically cooled houses. Not withstanding the prevalence of the bitter rot it has not been made the subject of any very extended investigations to determine means of preventing its ravages. The first American work was that of the U. S. Department of Agriculture. Since then some work has been reported from the Kentucky and Missouri Experiment Stations. These tests were primarily conceived for control of the scab, but the effect of the spray upon the bitter rot fungous was taken in account.

The most successful preventive measures so far employed for the control of the Bitter Rot are Bordeaux Mixture (the 6 lb. and 4 lb. mixture) or Ammonical Copper Carbonate.

This disease seldom makes an appearance upon the fruit before it is half grown. ; spraying to prevent it need not be begun earlier than July 15, but from that date until harvest time the treatment should be repeated once every fortnight or oftener should the season prove rainy. By thorough treatment the injury from this disease may be checked as much as from 50 to 75 per cent.

Brown Spot, Frog Eye.

(*Phyllosticta pirina.*)

So far as known this disease is at present confined to the southern States. It was reported from Virginia in Bull. 17,

1892, it is common throughout the southern and eastern counties of our State and has more recently been found in the high lands of the mountains bordering the Canadian zone thus indicating that northern orchardists should keep an eye out for the pest, as it is evidently capable of pushing its area of destruction far beyond its present boundary.

From a commercial stand point this disease is more injurious to the foliage of the apple than either the blight or scab fungous. The attacks of this enemy are entirely confined to the foliage of the tree. But its work is none the less to be dreaded

FIG. 2—Frog Eye.

on that account, for anything which lessens or interferes with the leaves or their functions affects the most vital portion of the plant.

When seriously affected the trees appear as though the leaves had been parched and blanched by the sun, but close inspection shows that the diseased areas are more or less localized and that the first indications of the disease are small brownish red spots which gradually enlarge, the center becoming lighter in color, and finally two or more diseased areas may run together forming a large irregular dead patch of tissue. A diseased leaf is shown at Fig. 2. Luckily this disease is more amenable to treatment than the Rust. In fact if the orchard is thoroughly treated with Bordeaux Mixture for the "Scab" there will likely be little or no injury from the Brown Spot. If untreated however, the disease may cause a serious loss as it works early in the season often causing the foliage to fall in July, . It may and usually does appear again in August or September and when this occurs the foliage falls early, before the fruits are grown and colored. Injury at this stage produces loss of flavor, lack of color, and improper maturity and probably a poorer-keeping product.

Apple Scab.

(*Fusicladium dendriticum*)

This menace to modern apple culture is perhaps the most common and the most damaging fungous foe of the orchardist. It attacks both the fruit and foliage, but causes the greatest loss to the orchardists just at the blooming season. The young fruits attacked by the fungous at this period became blighted and fall from the tree. This trouble has been variously attributed to insufficient nourishment for the tree, imperfect pollination and to cold or wet during the blooming season. All these factors have more or less influence upon the setting of the fruit but the attack of the scab fungous is responsible for a greater loss at this period, under ordinary cirumstanes, than all the other factors combined. Not only does the scab cause heavy

loss from dropping after blooming, but the fruits which escape at that period may be attacked later. Such fruits may remain upon the tree but their growth will be interfered with by the parasite to such an extent that at picking time the fruits will be small, irregular, rough, and blotched. In appearance the fruit may present only small irregular roughened brown spots, somewhat corky in nature, or the affected area may be large covering one-third or one-half of the surface of the apple in which case the skin become tough and woody and not unfrequently cracks open. In peeling the fruit the affected parts come off with the rind, unless the attack is severe when the flesh of the fruit, as well as the skin becomes corky, Fig. 3 illustrates fruits affected with the scab, This affection may be confounded with scars caused

FIG. 3—Scab on Fruit, after Lademan.

by the curculio but a little experience will teach the difference between the two markings. Upon the leaves the fungous appears as a sooty spot on the underside of the leaf; the upper surface showing a brownish discoloration. Upon close inspection the sooty areas look brown and velvety in early growth but assume a deeper shade later in the season. Affected leaves become yellow, and drop from the tree. If the attack is severe a considerable proportion of the foliage of the tree may be lost

thus interfering with its growth and also causing a premature ripening of the fruits. Fig. 4 represents a leaf as well as a fruit affected with the apple scab.

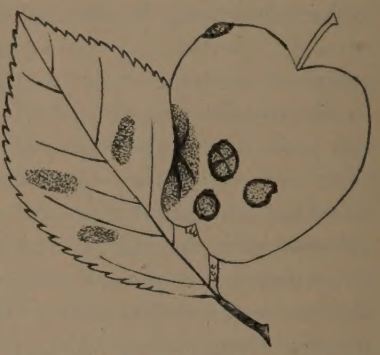

Fig 4—Apple Scab on leaf and fruit.

Treatment—This disease is prevented by spraying the plants before the buds break in the spring with a solution of Copper Sulphate 1 lb. to 15 gallons of water. As soon as the blossom buds are well formed and again as soon as the blossoms fall the trees should be treated with Bordeaux Mixture and Paris green or London purple, repeat this in two weeks and again in two or three weeks depending upon the weather. If it is rainy spraying should be done more frequently than would be necessary during a dry period, as the rains wash the sprays off the fruits and foliage leaving them exposed to the attack of the fungous which is more active during warm moist weather than during a dry time.

Apple Rust.

(*Gymnosporangium Macrocarpus*)

This disease is well named. Leaves attacked by it appear as though covered by an unusually heavy coat of iron rust in isolated patches. In more severe cases these patches are more or less closely connected and the whole under surface of the leaf will present a rusty appearance. Upon close inspection it will be noted that the affected areas are really outgrowths from the surface.

This disease is frequently met with in various sections of the State on the foliage of the apple. The fruit is seldom attacked by the rust but some varieties show more or less susceptibility to it. The Lawver or Delaware Red Winter is one of the sorts most often attacked by it. The rust upon the fruit is shown in

FIG. 5—Rust on Fruits

Fig. 5. Many of the low plants which prey upon our cultivated species present a very interesting life history in fact the peculiarities which they present are quite as surprising in their way as are the tranformations of insects.

The Apple Rust lives during a portion of its existence upon the apple as a host, affecting either its leaves or fruit in the manner above described. This same fungous appears in another and very different form upon the Red Cedar, causing what are popularly known as cedar apples. These apples during April and May become masses of gelatinous material usually irregular in outline, looking much like a mass of gelatine jelly

of a bright straw or orange color. During the fall and winter these showy ornaments existed as small chocolate colored galls, but with the advent of warm weather they assumed the form above described. In the mass of jelly-like tissue great numbers of reproductive bodies (spores) are produced; which when dry are carried by the wind to the apple leaves or growing fruits to produce the characteristic rust spots of Fig. 6. As has already been hinted the prevalence of the rust depends much upon the sort of apple. Its prevalence is also in proportion to the abundance of cedars in the vicinity of the orchard. The chief safe

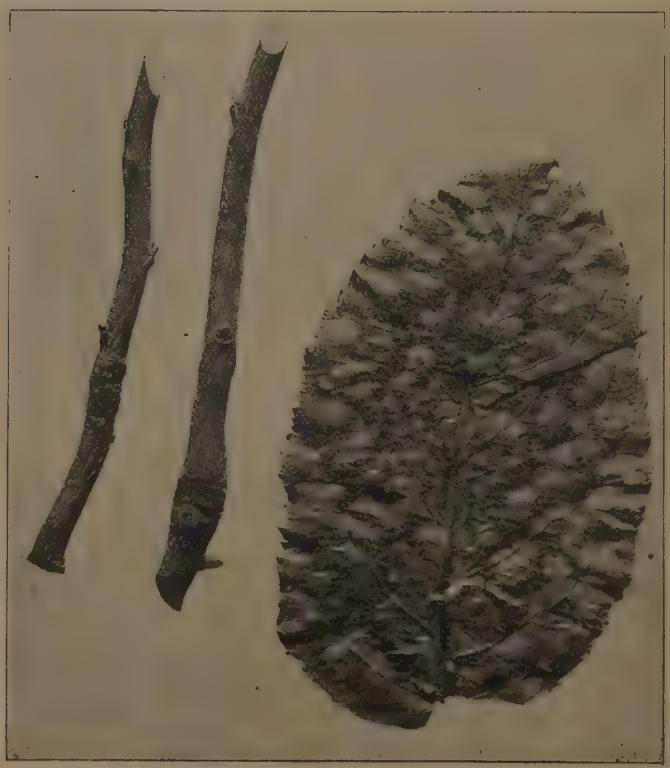

FIG. 6—Rust on leaf and twig.

guards lie therefore, in avoiding or in eliminating the cedar and in selecting resistent varieties; as the sprays so far discovered as fungicides have little effect in checking the disease. In fact I have found this malady in sprayed orchards where the foliage and fruits were free from scab and brown spot, indicating that the sprays used had less influence in checking the rust than in subduing the other troubles.

PEACH.

Black Spot of the Fruit.

(*Cladosporium carpophylum* Thm.)

This trouble is familiar to peach growers, especially on late varieties such as Hill's Chili. Sooty spots appear usually on one cheek of the fruit and nearer the stem than the distal end. These spots are seldom more than one-eighth inch across, but when several coalesce the affected area may be large, the growth of that portion checked and deep fissures often occur as shown in Fig. 7, a side view of which is represented in Fig. 8.

FIG. 7.—Black spot.

Fortunately this disease yields to treatment with the Bordeaux Mixture but in treating the peach care must be exercised in preparing the "mixture" in order that injury to the foliage may be avoided. Peach leaves are very tender and are easily injured by strong solutions. For treating the black spot of the fruit a solution made from 4 lbs. copper suluphate and 4 lbs. of lime diluted with 50 gal. of water will be found to be less injurious to the foliage than the standard 6 lbs. sulphate solution. Spraying for black spot should begin early in July and be repeated according to the weather at intervals of 10 days to two weeks until the middle of August. If later treatments seem to be necessary Ammoniacal Carbonate of Copper should take the place of the Bordeaux Mixture in order that the fruits may not show stains at picking time.

Brown Rot.

(*Monilia fructigena.*)

Fig. 8.

Aside from the "Yellows" peach growers have no more destructive disease to contend with than the Brown Rot. It is not content with the peach as a host plant but preys upon the plum and cherry causing great loss.

The failure of the sweet cherry throughout large sections of our State is chiefly due to the Brown Rot, and there is no trouble connected with commercial plum growing more serious than this.

The European—Domestica types of plums seem to suffer more severely from this disease than do the Japan or American types.

Early peaches, however, are more susceptible as a class than are the late varieties. The disease is distributed throughout the peach belts of West Virginia, Deleware, Maryland and New Jersey. It spreads rapidly during warm and moist weather. Peaches which touch each other seem to be most easily affected hence the necessity of careful early thinning of the fruit. If the fruits are judiciously thinned the treatment of the trees for the Black spot of the fruit, with the dilute Bordeaux mixture will undoubtedly serve to hold the disease in check.

A characteristic result of this trouble is shown in Fig. 9, where the dried fruits are still clinging to the branch. In many cases these mummified fruits remain attached to the twigs from year to year and as the reproductive bodies of the disease are retained in these fruits they serve as a store house for carrying the spores one year to the next. At picking time it is a good practice to pull off all affected fruits and either destroy them or allow hogs to run in the orchard to consume them; dry fruits that will not be consumed by the hogs should be destroyed or buried by cultivation in the fall.

FIG. 9.—Brown rot.

The fact that this disease finds a congenial host upon the cherry, plum and peach, renders it more difficult to treat than fungi which confine their attack to single host plant. Upon the cherry it often causes severe loss, in some cases the entire crop of fruit beside affecting the foliage. Because of the small size of the mummy fruits of the cherry hand picking them is quite out of the question, yet if these fruits are allowed to remain they prove a menace to peaches or plums growing near.

Growers who contemplate the cultivation of sweet cherries, plums and peaches in the same orchard should bear these facts in mind and prepare to take the consequences if this disease is allowed to gain a foothold upon any one of these fruits.

Leaf Curl.

(*Exoascus deformans.*)

The popular name of this disease so fully describes it that little need be said in regard to its general appearance here, more than to call attention to Fig. 10, which shows the characteristic appearance of diseased leaves. The leaf curl usually manifests its presence early in the season. The leaves become deformed, and frequently assume a reddish color later turning yellow and falling from the tree. In severe cases the trees may be almost completely defoliated, and such trees, although they quickly send out new foliage, seldom bear fruit. Until recently the

FIG. 10.—Leaf curl.

trouble has not been successfully controlled but experiments by the United States Division of Vegetable Pathology carried on in California as well as those by Cornell University Experiment Station in New York indicate that the disease is amenable to treatment. The following Bordeaux Mixture formula is given as the successful remedy.*

"Bordeaux Mixture—Prof. Pierce's Formula.

Remedy for Leaf Curl—A Fertilizer and Invigorator of the Tree.

5 lbs. copper sulphate (blue stone.)
5 lbs. quick lime.
45 gallons water.

Dissolve the copper sulphate, (blue stone), in a barrel containing ten or twelve gallons of water. Slack the quick lime and thin it to a creamy whitewash. Pour the whitewash very slowly through a wire screen into the copper solution. Stir the mixture thoroughly and add enough water to make 45 gallons in all. Stir occasionally while applying as a spray to the trees.

In the preparation of the Bordeaux Mixture it is necessary that the ingredients should be mixed in a wooden vessel. If an iron vat is used the copper will go to the iron and the effect of the spray is largely neutralized. Apply the remedy cold and as soon after it is prepared as possible. Never allow it to stand over night.

In a letter to the Horticultural Commissioners of Sutter county,† Prof. Pierce says that the above wash is a fertilizer and invigorator of the tree and will effectually prevent leaf curl if applied very thoroughly from one to three weeks before the buds open.

Of Bluestone only the best quality should be used. There is a good deal of variation in bluestone, as it contains always more or less iron sulphate, or copperas, but this is readily discernible, and a sample that contains any considerable amount of rust color copperas should not be used."

*See Cornell University Experiment Station Bulletins, Nos. 164 and 180.
†California.

Yellows.

To-day comparatively few of the more troublesome plant diseases hold their true cause a secret. The life history of the Brown Rot, the Black Spot, the Leaf Curl, etc., is well understood, yet notwithstanding the fact that probably more time, money and skill has been expended on the study of the yellows than any of the diseases mentioned, its true cause is yet a mystery. It is like some of the forces we make use of in nature we know them only through their work. The symptoms and characters of yellows are well known and are remarkably constant, yet the inciting cause is not yet known.

"The one unmistakable symptom of the yellows is the red spotted character of the fruit." The flecks shown on the peach illustrated in Fig. 11 represents the character and distribution of such spots. The flesh of such peaches is usually marked by red lines or splashes beneath the spots, somewhat in the fashion shown in Fig. 12. Fruits showing these characters usuallly ripen prematurely; in the second year they are usually much smaller and more fuzzy than the normal fruits. Such fruits may ripen ten days or two weeks sooner than the normal period for the variety, and are usually bitter or insipid in flavor.

FIG. 11—Yellows Peach.

"The second symptom, or the first in trees not of bearing age, is the tip growth. This is a short growth starting from the upper or terminal buds, usually late in the season, and is characterized by narrow, stiff, yellowish small leaves which stand at nearly right angles to the shoot, sometimes these tips appear late in autumn after the leaves have fallen, or in spring before normal growth begins. They are often first seen upon the edges of water sprouts. "The difference in appearance shown by a

healthy terminal shoot and a "yellows" tip is shown in the accompanying illustration Fig. 13, being a normal healthy tip while Fig. 14 is a "yellows" tip. "The third mark of the disease is the pushing out of slender stiff-leaved yellowish shoots from the body of the tree or the sides of the large limbs as shown in Fig. 15, p. 217. In pronounced cases, or where the tree is about to die, these shoots may branch into close bunchy tufts."

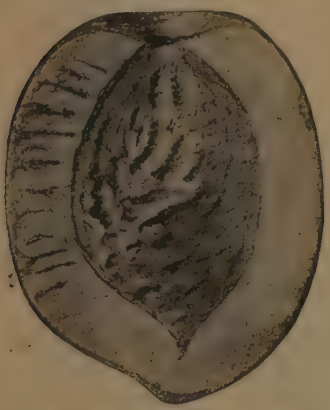

Fig. 12—Cross-section of Yellows Peach.

"In its final stage, the disease is marked by small and slender growth of all new wood, small, narrow, yellow or reddish foliage, and occasionally by a great profusion of slender and branchy growths in the center of the tree. As a rule, yellows trees die in five or six years from the first visible attack."

The disease does not confine its attack to the peach but is reported from the almond, apricot and the Japanese plums. It is capable of being carried from tree to tree, but the method by which it is carried is unknown. It is not spread through the soil for healthy trees can be planted with safety in areas where "yellows" trees have been removed.

Since the true cause of the disease is unknown, the only means of holding it in check is to eradicate the diseased trees as soon as discovered. The fruit laws of New York and Michigan are emphatic on this point.

PEAR.

Leaf Blight; Fruit Spot,

(*Entomosporium maculatum.*)

Aside from "fire blight," which causes the loss of branches and in some cases the death of the whole tree, there is no enemy of the pear grower which produces greater loss than the leaf

blight or fruit spot. Like apple scab this trouble works both upon the foliage and fruit. The leaves become affected early in the season, often by June first, and by the last of July the foliage may be almost entirely off the trees. The quince is also attacked by this disease. The affected leaves of the pear show small brownish spots, which increase in size and often run together causing the destruction of large

Fig. 14—Yellows Shoot.

Fig. 13—Normal Peach Tip.

areas. Diseased leaves fall to the ground and if the attack is severe almost the entire foliage of the tree may fall. Upon the fruit the disease is first manifested by the red-dish brown spots which later turn black. If the fruits are attacked when small the diseased area grows slowly, becomes hard and corky causing

Fig. 15—Yellows Branch.

FIG. 16—Pear Scab.

the pear to become distorted and often cracked in the affected area.

Fortunately for the growers the leaf blight readily yields to treatment with Bordeaux Mixture or Ammoniacal Copper Carbonate. The first spraying should be done as soon as the leaves appear, and repeated at intervals of from two to four weeks according to atmospheric conditoins; more treatments being necessary during wet than during dry weather. Spraying should not be abandoned until about August 1st. In case later treatments appear necessary Ammoniacal Copper Carbonate should be substituted for Bordeaux Mixture as it will not leave the fruits stained for market.

Pear Scab

(*Fusicladium pirinum.*)

In its general results the Pear Scab closely resembles the Leaf Blight. Both destroy the foliage and both may cause the fruit to crack. The botanist distinguishes between the two by their habits of growth, but for our purpose the effects which each produces together with means for controlling them are of greater moment.

A fruit injured by the Pear Scab is shown in Fig. 16, and the figure might with propriety be used to indicate the results of an attack by the Leaf Blight or Fruit Spot.

The first gross character of this disease to appear upon the fruit are sooty spots, which are not unlike the apple scab fungus upon the leaves of the apple, as the fungus developes the epidermis of the fruit, as well as, the tissue underneath it looses its color, nourishment seems to be cut off and the affected area becomes dead and woody, and as a result of the growth of adjacent parts, the affected part cracks as shown in the figure.

The "Scab" is successfully treated with the standard Bordeaux Mixture; the treatment for the Leaf-blight will accomplish both.

PLUMS.

Brown Rot.

(*Monilia Fructigena.*)

This diesase which affects the plum. as well as, cherry and peach illustrated in Fig. 9 and Fig. 17 has been discussed under the head of Peach diseases, See pages 210-211.

Fig. 17—Brown Rot.

Shot Hole Fungus.

(*Cylindrosporium padi.*)

While this disease bears no resemblance to the leaf curl of the peach, the result of its work upon the plum is much the same as that of the leaf curl on the peach in that it causes the loss of the foliage.

Early in the summer small circular spots, about one-eighth inch in diameter appear upon the leaves of plums and cherries. The spots are at first purplish in color but later they turn to a brown as the result of the death of the tissue. The dead tissue falls away leaving more or less circular holes which gives the

Fig. 18.—Shot-hole fungus.

leaf the appearance of having been pierced by shot as shown in Fig. 18 hence the name shot-hole fungus. If not treated the foliage of the tree may be entirely destroyed thus causing not only a serious check to the growth of the plant but the casting of its fruit as well. Fortunately the disease yields to treatment with Bordeaux Mixture. The first spraying should be made as soon as the leaves appear, and repeated at intervals of two to three weeks until the middle of July after which time all treatments on bearing trees should be made with Ammoniacal Copper Carboante otherwise the fruit would be stained and somewhat damaged for market purposes. Usually, however, spraying later than July 15, will not be necessary.

Black Knot

(*Plowrightia morbosa.*)

The black warts or knots Fig. 19 common upon the cherry and plum are usually attributed to the work of insects. These growths or galls are the result of a fungus growth, and the insects which are often found in them are there merely because they find the galls convenient and suitable hibernating or breeding place. The life history of this pest is not entirely clear to the botanist as yet, but enough is known to suggest the course to pursue in treating the malady.

In general best results are obtained from cutting out and burning all infested branches. Supplement this by spraying

the trees early in the season before the buds burst with a solution of Copper Sulphate. At the time the buds are opening the trees should receive an application of Bordeaux Mixture (4lb. by 4lb. mixture), this application to be repeated during the last week in May and again about the middle of June.

Knots upon large limbs or upon the trunks of trees where they can not be readily removed should receive a thorough application of kerosene oil with a brush.

Fig. 19.—Black knot.

GRAPE.

Black Rot.

(*Læstadia bidwellii* V. & R.)

The blackened and shriveled fruits left adhering to the stem as the result of the attack of this disease and shown in Fig. 20, is sufficient excuse for the common name of the trouble. This disease, like the mildews and anthracnose, attacks other parts of the vine than the fruit, although in this case outbreaks not involving the fruit are of little moment to the grower. This malady causes greater aggregate loss to the grower from year to year than all others combined. Usually the fruits affected by the black rot are nearly or quite full grown. If the fruits are green when they become infested the diseased berry shows a local discoloration which gradually involves the whole berry; the normal form is retained, it is firm but of a purplish brown color. The berry then begins to shrivel, becomes sharply ridged, the seeds showing prominently through the skin, the entire berry turns black but upon close examina-

FIG. 20—Black Rot.

tion it will be found that the surface is covered by minute elevations.

During warm, moist periods, or just before ripening, a close watch should be kept for an indication of the disease. The first intimation that it is present should be followed by an immediate application of Bordeaux Mixture.

The safest plan to follow here, where the Downy Mildew and Black Rot are both so liable to occur, is to begin treatment with Bordeaux Mixture early in the season as mentioned under Downy Mildew and keep it up until the fruits show indications of ripening when Ammoniacal Carbonate of Copper should be substituted for the Bordeaux Mixture to prevent staining of the fruits.

Downy Mildew; Brown Rot.

(*Peronospora viticola* De.)

Of the two mildews affecting the vine in this country the Downy Mildew is of the greater economic importance. It is another of the long list of pests of this character which attack both the fruit and vital organs of the plant. On the grape the downy mildew attacks fruits, leaves and branches although in the latter position it seldom occurs to an injurious extent. On the fruit and leaves is where the serious damage is caused.

"The foliage first shows the presence of the parasite by portions of the leaf turning a lighter green than that of the normal tissue. Later, these parts turn yellow, when the destruction of the tissue is complete the parts affected are of a brown color. If the under surface of such leaves is examined, it will be found that there is a frost-like substance projecting from the discolored parts of the leaf after the upper surface has begun to turn yellow." A leaf affected with the downy mildew is shown in Fig. 21 in which an illustration of the discoloration of the upper surface as well as the frost-like character of the under side of the leafhas been attempted.

Fig. 21—Downy Mildew on Leaf.

"The fruit is also very susceptible to the attacks of the downy mildew; but when that is affected, the vine does not suffer so much as does the grower. In the case of diseased foliage, the crop of the next year, as well as that of the present is threatened; but with diseased fruit it is only a matter of the present year, which is all-suf-

FIG. 22.—Downy Mildew.

ficient to make the grower anxious to know what can be done."

In this State we may expect an outbreak of this trouble on the partially developed fruits during the early days of July. Affected berries at first turn a dirty brown color and later become covered with a whitish powder which gives them a gray or brown color as shown in Fig. 22.

If this disease is known to be present in a locality treatment with Bordeaux Mixture should begin soon after the growth starts in order that there shall be the least possible loss of crop. A second application should be made immediately after blooming time, and these followed by others at intervals of two to three weeks as conditions suggest.

Anthracnose, Bird's-eye Rot.

(*Sphaceloma ampelinum* De Bary.)

The term Bird's-eye Rot so fully distinguishes this disease from the Black and Brown Rots that no further description of it will here be given.

While it is a more or less common affection of the grape in this country European vine dressers have given its treatment more attention and have succeeded in mastering it very effectually. Tests of the European remedies in this country have proven them to be of high merit in our climate. In addition to the line of treatment suggested for Black and Brown Rot, vineyards infested with anthracnose should have a winter treatment consisting of thoroughly spraying the dormant vines and stakes with a solution of sulphate of iron in sulphuric acid. This should be prepared:

Sulphate of Iron..... 110 pounds.
Water (warm) ..... 26 gallons.
Sulphuric Acid, 53°.....1½ pints.

RASPBERRY.

Orange-Rust or Red Rust.

(*Cœoma luminatum*, Link).

This disease is so conspicuous and so well known both upon the leaves and shoots of raspberries and blackberries that no further description appears necessary. The disease is an exceedingly serious one, the more so because no successful preventive measures are known and since the trouble is perenial in nature, a plant once affected can never be cured. To hold the trouble in check will require the closest attention upon the part of the grower, in removing and burning diseased plants as soon as detected. Peach yellows and Raspberry Rust stand on a par at present and must be dealt with in the same manner.

The importance of what I have said was emphatically brought home to my notice while passing through that section of the United States where raspberry growing is more extensively

engaged in than in any other, by the great prevalence of the disease and the appearant helplessness of the grower to contend with it. In fact most old patches had literally been "struck by the rust" hundreds of acres of raspberries were worthless because of the presence of this disease. Let us take warning.

STRAWBERRY.

Leaf Blight, Leaf Spot

(*Sphærella Fragariæ* Sacc.)

The strawberry is like other fruit bearing plants the host for injurions fungous pests.

In this case the foliage is the part injured. The first indication of the disease is the appearance of purplish spots which grow in size until they are on an average one-eighth to three-sixteenths of an inch in diameter as shown in Fig. 23. As the diseased area increases in size the center of the spot turns to a bright reddish brown, which grows lighter colored as the disease progresses, the purple boundary is preserved until the whole leaf becomes involved and as a result useless to the plant, such leaves soon become brown and dead.

The fungus passes the winter in such leaves consequently any treatment looking to the check of the malady must carry with it the removal and destruction of infested leaves. this can best be done by mowing off, removing and burning all grass and infested leaves after the crop is harvested, then spray the young growth with Bordeaux Mixture.

Fig 23.

As varieties show marked differences in their susceptibility to this disease, it should be the aim of the cultivator in selecting his varieties to combine this resistant character with the desired shape and quality of fruit.

SPRAY CALENDAR.

NAME OF PLANT.	NAME OF TROUB'E	I TREATMENT.	II TREATMENT.	III TREATMENT.	IV TREATMENT.	V TREATMENT.
APPLE.	Scab.	Copper sulphate solution before buds break.	Bordeaux mixture when leaf buds are open but before flower buds expand	Bordeaux mixture and Paris Green as soon as blossoms have fallen.	Bordeaux mixture 10—12 days after (III).	Repeat (III) once or twice at intervals of two weeks.
	Rust.	" "	" "	" "	" "	" "
	Brown Spot.	Bordeaux mixture at same time as Treatment II for Apple Scab.	Same as III for Apple Scab.	Same as IV for Apple Scab.		NOTE—This disease is liable to cause loss of foliage near harvest time. Ammoniacal Copper Carbonate should be used for late treatments.
	Bitter Rot.	Bordeaux mixture about July 15 as a safeguard.	Bordeaux mixture 10 days later.	Ammoniacal Carbonate of Copper as substitute for Bordeaux as soon as fruits are three-fourths grown.		
	Tent Caterpillar.	Paris Green in II treatment for Scab.				
	Canker Worm.	Paris Green or London Purple berore blossoms open or as soon as they fall.				NOTE—To lessen expense combine insecticides and fungicides, i. e. use Paris Green or London Purple with Bordeaux mixture whenever the poison is desired.
	Codlin moth.	Paris Green or London Purple see III treatment for scab.	Repeat (I) in 8 to 10 days.	Repeat (I) in two weeks after (II).	Repeat (I) if second brood is troublesome.	
	Bud-moth.	Paris Green as soon as tips of leaves show in bud.	Repeat (I) before blossom buds open.			
CHERRY.	Black-knot.	Bordeaux mixture during first warm days of spring.	Repeat when buds are swelling.	Repeat (I) Treatment during latter part of May.	Repeat (I) Treatment about middle of June.	Repeat (I) in July. Note—Cut and burn all infested branches during early winter.

SPRAY CALENDAR.

NAME OF PLANT.	NAME OF TROUBLE	I TREATMENT.	II TREATMENT.	III TREATMENT.	IV TREATMENT.	V TREATMENT.
CHERRY.	Shot hole Fungus.	Bordeaux mixture as soon as leaves appear.	Repeat [1] on trees not bearing fruit every ten days to two weeks.	Ammonical Copper Carbonate on fruiting trees after first treatment.		
	Rot.	Bordeaux mixture when buds break.	Repeat [1] as soon as fruits set.	Ammonical Copper Carbonate when fruits are grown.		
	Aphis.	Kerosene emulsion as soon as insects appear.	Repeat every 3 or 4 days until pests are exterminated.			
	Slug.	Paris Green, hellebore or air-slaked lime when insects appear.	Repeat in 10-12 days if there is occasion for it.			
CURRANT.	Anthracnose, Leaf blight.	A thorough treatment early in season with Bordeaux mixture will probably prove sufficient.				
	Rust, Leaf Spot.	Ammonical Copper Carbonate before harvest.	Bordeaux mixture after fruits have been gathered.			
	Currant Worm.	Paris green as soon as first leaves appear.	Paris green about 10 days later.	If worms again appear before fruit is gathered, use hellebore.	NOTE:—As several broods of this insect appear during the season, constant attention is therefore necessary.	
	Four lined Leaf bug.	Kerosene emulsion with 9 per cent. of oil used early in morning upon immature insects.				
	Green Leaf hopper.	Kerosene emulsion applied to the under surface of the leaf.				

SPRAY CALENDAR.

NAME OF PLANT	NAME OF TROUBLE	I TREATMENT.	II TREATMENT.	III TREATMENT.	IV TREATMENT.	V TREATMENT.
GOOSEBERRY.	Mildew.	Bordeaux mixture before buds break.	Bordeaux mixture when first leaves have expanded.	Repeat [1] at intervals of 8 to 10 days during season if necessary.		
	Currant Worm.	Same as given under current.				
GRAPE.	Anthracnose.	Sulphate of Iron and Sulphuric Acid solution before buds break in spring.	Repeat [I] after 3 or 4 days to cover untreated portions in first application.	Bordeaux mixture after fruits set same as for Black rot.		
	Black-rot.	Bordeaux mixture as soon as fruits have set.	Repeat [I] at intervals of 10 days to 2 weeks, until fruit is nearly grown.	Ammoniacal Copper Carbonate during ripening period at intervals of 7 to 10 days as needed.		
	Mildew.	Bordeaux mixture as soon as first leaves are fully expanded.	Later treatment same as for Black-rot.			
NURSERY STOCK.	Fungous diseases.	Bordeaux mixture when leaves first appear.	Repeat [I] at frequet intervals in order that the foliage may be kept well covered—10—14 days.			
PEACH, APRICOT, NECTARINE.	Brown rot.	1. Copper Sulphate solution before buds open.	2. Bordeaux mixture before flowers open.	Repsat [II] when fruit has set.	Repeat at intervals of 7 to 14 days until fruit is nearly grown.	Ammoniacal Copper Carbonate every 5 to 12 days during coloring and ripening period.
	Leaf-curl.	Bordeaux mixture before buds open in spring.	" "			
	Yellows,	NOTE.—Clean trees, clean culture and the removal of diseased specimens as soon as they appear.				

SPRAY CALENDAR.

NAME OF PLANT.	NAME OF TROUB'E	I TREATMENT.	II TREATMENT.	III TREATMLNT.	IV TREATMENT.	V TREATMENT.
PEAR	Leaf-blight or Fruit spot and crack.	Bordeaux mixture just before blossoms open.	Repeat [I] as soon as fruit has set.	Repeat [I] at intervals of two weeks until fruit is nearly grown.		
	Leaf-blister	Kerosene emulsion before buds open in spring, dilute only 5—7 times.				
	Slug.	Note treatment described under cherry.				
PLUM.	Brown-rot.	Note treatment described for peach.				
	Black-knot	Repeat directions given under cherry.				
	Leaf Blight. Shot-hole Fungus.	Bordeaux mixture as soon as leaves appear.	Repeat [I] on trees not in fruit every 10 days to 2 weeks.	Ammoniacal Copper Carbonate on trees in fruit as soon as fruits are two-thirds grown.		
	Curculio.	Paris Green as soon as fruits are set; repeat in 3—5 days.	NOTE.—Spraying should not be depended upon. Jar the trees at intervals of 1—3 days for first 2 to 3 weeks after fruit has set.			
	San Jose scale.	Pure Kerosene or Crude Petroleum before buds break in spring.	NOTE.— Remedies are in general a delusion—destruction of the trees by fire is the only safeguard.			

SPRAY CALENDAR.

NAME OF PLANT.	NAME OF TROUBLE	I TREATMENT.	II TREATMENT.	III TREATMENT.	IV TREATMENT.	V TREATMENT.
RASPBERRY. BLACKBERRY.	Anthracnose. Orange-rust.	NOTE.—The cheapest and most efficient way is to remove all diseased branches or plants as soon as they appear.				
	Gouty-Gall Beetle.					
	Saw-fly.	Paris Green or London Purple as soon as leaves have expanded.	Repeat in 10 days or 2 weeks, or apply kerosene emulsion			
STRAWBERRY.	Leaf-blight.	Bordeaux mixture when growth begins in spring.	After picking cut, remove and burn all vegetation; spray new growth with Bordeaux mixture.			

DIRECTIONS FOR MAKING INSECTICIDES AND FUNGICIDES.

Contact Insecticides.

The following insecticides are those which kill by contact. The essential principle of any mixture of this class must be a volatile oil of considerable penetrating power in order that it shall act upon the body of the insect, or it shall be a heavy substance capable of forming a coating over the body of the inscet and thus prevent the power of respiration. In any case the material used, while sufficient to act upon the body of the insect must not be injurious to the delicate tissues of the plant.

KEROSENE EMULSION.—Soft soap, 1 quart, or hard soap, $\frac{1}{4}$ pound; 2 quarts hot water; 1 pint kerosene. Stir until thoroughly mixed; then dilute with water, using one part of the emulsion to three or four of water. The most satisfactory way of making an emulsion is to use a force pump for mixing; pumping the mixture back into the receptacle several times.

Another method is to use hard soap, $\frac{1}{2}$ pound; boiling water, 1 gallon; kerosene, 2 gallons. Churn or pump the ingredients thoroughly for fifteen miuntes. Dilute ten times when using.

KEROSENE AND MILK EMULSION.—Sour milk, 1 gallon; kerosene oil, 2 gallons; warm to blood heat and mix thoroughly. Dilute 10 times with water and use as a dip or spray.

LYE WASH.—1 pound concentrated lye, or 16 pounds of potash, to three gallons water. This may be applied to branches of trees with brush as a remedy for bark lice.

PYRETHRUM (Buhach).—Used dry by dusting upon or beneath the plants. In Alcohol:—Put one part of pyrethrum (buhach) and four parts alcohol, by weight, in any tight vessel. Shake occasionally, and after eight days filter. Apply with an automizer. Excellent for green house pests. For some plants it needs to be diluted a little. Another good way is to dissolve about four ounces of powder in 1 gill of alcohol and 12 gallons of water.

SOAP AND TOBACCO.—Dissolve 8 pounds of the best soft soap in 12 gallons of rain water, and when cold, add 1 gallon of strong tobacco liquor.

TOBACCO AS COARSE DUST OR "TOBACCO FERTILIZER."—

Strewn under melons and squash plants. About roots of apple for wooly aphis.

TOBACCO TEA.—Used as a spray for plant lice, is made by steeping stems or leaves in water for a couple of hours.

Poisonous Insecticides

Insecticides of this class kill by being taken into the system of insects for which they are used. Arsenic and its compounds form the active agent of most of such insecticides.

PARIS GREEN.—As a spray use 1 pound to 200 gallons of water. Keep well stirred so that the poison shall be held in suspension. If this is neglected the green will settle to the bottom of the vessel, as it is not soluble in water ,and the result will be that the spray will contain little poison at first and too much towards the last. In spraying stone fruits use the mixture more dilute, 1 pound of poison to 300 gallons of water.

LONDON PURPLE—This poison should be used same as Paris Green. 1 pound to 200 gallons of water. It should never be used upon peach trees, because the foliage is very susceptible to injury from the soluble arsenic.

WHITE HELLEBORE.—Used as a spray. 1 ounce of the poison to three gallons of water. When applied dry it is seldom mixed with anything. A little flour, however makes it more adhesive.

Fungicides.

At the present time the use of fungicides is quite as important as the use of insecticides in the culture of fruits and vegetables.

AMMONIACAL COPPER CARBONATE.—The stock solution is made by adding 5 ounces of carbonate of copper to 3 pints of ammonia (26 degrees), this may be kept any length of time in a bottle with a glass stopper. For use dilute with 45 gallons of water.

BORDEAUX MIXTURE.—Dissolve 6 pounds of sulphate in a wooden or earthen vessel. In another tub or vessel slake 4 pounds of *fresh* lime; add enough water to reduce it to the consistency of a thick white wash. Pour this slowly into the vessel containing the copper sulphate solution, using a course gunny sack stretched across the top of the vessel for a strainer. Dilute to 45 gallons before applying to plants of any kind.

MERCURIC CHLORIDE.—(Corrosive Sublimate) made by "dissolving 2 ounces of the chloride in 2 gallons of water and letting it stand several hours, or over night, and diluting to 16 gallons." Corrrosive sublimate is very poisonous and should be used with caution. In applying the mixture always use a wooden or earthen vessel.

POTASSIUM SULPHIDE.—Dissolve 3 ounces of potassium sulphide (liver of sulphur) in 10 gallons of water.

COPPER SULPHATE SOLUTION.—(Standard solution.) Dissolve 1 pound of copper sulphate in 25 gallons of water. This solution is

too strong to be used upon the leaves of plants, and should only be applied to the branches before buds start in the spring.

DILUTE COPPER SULPHATE SOLUTION.—One pound of copper sulphate dissolved in 250 gallons of water.

VERY DILUTE COPPER SOLUTION.—Made by dissolving one pound of copper sulphate in 500 gallons of water.

These weak solutions are only to be used in case of necessity late in the season when a treatment with Bordeaux Mixture would leave the fruit discolored and spotted at marketing time. The dilute copper sulphate solution is safely used on nearly all plants except peaches, plums and beans.

IRON SULPHATE AND SULPHURIC ACID SOLUTION.—"To 6 pounds of Iron Sulphate add 1 gill of commercial Sulphoric Acid and upon this pour 3 gallons of hot water. Do not prepare the solution until desired for immediate use.

COMBINATION OF INSECTICIDE AND FUNGICIDE.—The only safe combination of this character, is that of Bordeaux mixture and Paris green or London purple. The combination of these mixtures results in no injury to the foliage of the plant treated, and yet each retains its value to the extent of being as good as when used separately. The great value of the combination is in lessoning the cost of the treatment, for we save the cost of one application. In preparing the mixture use the formula for Bordeaux mixture and add to it the Paris Green or London purple at the rate of 1 pound to each 200 gallons of the mixture. While using keep the mixture well stirred.

Acknowledgement.

The writer wishes to express thanks to the Cornell University Experiment Station for permission to reproduce cuts No. 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17, in this publication.

L. C. CORBETT.

Notice.

Application for bulletins of this Station should be addressed to the Director of the West Virginia Agricultural Experiment Station, Morgantown, W. Va.

(The bulletins named below are available for distribution.)

No. 4.—The Creamery Industry; its Adaptability to West Virginia
No. 5.—The Selection of Milch Cows.
No. 6.—Six Month's Experience in Running a Creamery; Improved Process of Handling Cream and Churning.
No. 12.—The Canada Thistle.
No. 14.—Farm and Garden Insects and Experiments with Remedies; Note of the Season.
No. 15.—Raspberry Gouty-Gall Beetle.
No. 16.—Yellow Locust, Insect Ravages upon.
No. 17.—Black Spruce, Insect Ravages.
No. 19.—Your Weeds and Your Neighbor's, Part 1. Weeds as Fertilizers.
No. 20.—Potato Culture and Fertilization. Tests of some Varieties of Tomatoes.
No. 21.—Injurious Insects and Plant Diseases.
No. 25.—Plat Experiments with Commercial Fertilizers on Wheat.
No. 26.—Inspection of Commercial Fertilizers.
No. 27.—Notes on Pruning.
No. 28.—Plat Experiments with Commercial Fertilizers on Corn.
No. 29—Experiments with Potatoes at the Station. Experiments on Corn at the Out-Stations.
No. 30.—Address and Notes on Sheep.
No. 33.—Sub-Irrigation in the Green House.
No. 38.—Potato Blight, Potato Scab.
No. 40.—Commercial Fertilizers.
No. 42.—Vegetables.
No. 43.—When, Why, What and How to Spray.
No. 44.—Practical Entomology.
Special Bulletin No. 2.—Proceedings connected with the celebration upon the completion of the Station Building and the organization of the Sheep breeders and Wool-Growers' Association and the State Horticultural Society.
Third Annual Report, 1890.
No. 51.—Commercial Fertilizers, Jan. '98.
No. 52—Strawberries.
No. 53.—Commercial Fertilizers, Dec. '98.
No. 54.—Nursery Hints.
No. 55.—Sugar Beets.
No. 56.—Report on Investigations to determine the Cause of Unhealthy Conditions of the Spruce and Pine From 1880-1893.
No. 57.—Commercial Fertilizers.
No. 58.—The Effect of Pressure in the Preservation of Milk.
No. 59.—Whole Corn Compared with Corn Meal for Fattening Hogs.
No. 60.—Poultry Experiments.
No. 61.—Sheep Feeding Experiments.
No. 62.—A Study of the Effects of Incandescent Gas-light on Plant Growth.
No. 63.—Commercial Fertilizers, 1899.
No. 64.—Sugar Beet Investigation in 1899.
No. 65.—Commercial Fertilizers.